IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant:	TOMINAGA KOJI ET AL.	)
		) Group Art Unit: 2813
Serial No.:	10/550,805	)
		) Examiner: Luke, Daniel M.
Filed:	July 12, 2006	)
		) Confirmation No. 3990
For:	METHOD FOR FORMING AN INSULATING FILM IN A SEMICONDUCTOR DEVICE	)))

VIA EFS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT

Sir:

This amendment is respectfully submitted in response to the Office Action dated January 21, 2010. Applicants hereby respectfully petition for a two-month extension of time. If there are any charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130 maintained by Applicants' attorneys.

Please amend the Application as follows:

IN THE CLAIMS

Complete listing of the claims:

1. (Previously presented) A method of forming an insulating film in a semiconductor device, the method comprising:

sequentially repeating a plurality of times:

forming a partial insulating film, wherein the partial insulating film has a thickness in the range of 0.3 to 2 nm; and

removing impurities from the partial insulating film, wherein the removing impurities is performed at a temperature greater than 500°C;

wherein the removing impurities comprises removing residual carbon.

2. (Previously presented) The method of claim 1, wherein the removing impurities is performed in a reducing gas atmosphere or an oxidizing gas atmosphere.

3. (Currently amended) The method of claim 1, wherein the removing impurities comprises:

removing impurities in a first treatment in a reducing gas atmosphere; and

removing impurities in a second treatment in an oxidizing gas atmosphere.

4. (Previously presented) The method of claim 2, wherein the reducing gas atmosphere comprises an ammonia gas, a hydrogen gas and an inert gas, a combination comprising at least one of the foregoing gases, or plasma nitrogen, or the reducing gas atmosphere is formed in a vacuum.

5. (Previously presented) The method of claim 2, wherein the oxidizing gas atmosphere comprises an oxygen gas, a nitrogen monoxide gas, a nitrous oxide gas, an ozone gas, or a combination comprising at least one of the foregoing gases, or plasma oxygen.

6. (Previously presented) The method of claim 3, wherein the reducing gas atmosphere comprises an ammonia gas, a hydrogen gas, an inert gas, or a combination comprising at least

one of the foregoing gases, or plasma nitrogen, or the reducing gas atmosphere is formed in a vacuum.

7. (Previously presented) The method of claim 3, wherein the oxidizing gas comprises an oxygen gas, a nitrogen monoxide gas, a nitrous oxide gas, an ozone gas, or a combination comprising at least one of the foregoing gases, or plasma oxygen.

8. (Previously presented) The method of claim 1

wherein the partial insulating film has a thickness in the range of 0.5 to 2 nm.

9. (Currently amended) A method of forming an insulating film in a semiconductor device, the method comprising:

sequentially repeating a plurality of times:

forming a partial insulating film, wherein the partial insulating film has a thickness in the range of 0.3 to 2 nm; and

removing impurities from the partial insulating film<u>, wherein the removing impurities is performed at a temperature greater than 500°C;</u>

wherein the removing impurities comprises:

removing impurities in a first treatment in a reducing gas atmosphere; and

removing impurities in a second treatment in an oxidizing gas atmosphere; and

the removing impurities comprises removing residual carbon.

10-12 (Cancelled)

13. (Previously presented) The method of claim 1, wherein the removing impurities comprises desorbing CO_2.

14. (Previously presented) The method of claim 1, wherein the removing impurities comprises desorbing CO_2, CH_4,C_2H_6, or a combination comprising at least one of the foregoing gases.

15. (Currently amended) The method of claim 1, wherein the forming the partial insulating film comprises depositing a precursor, wherein the precursor is an Al precursor, an Hf precursor, or a combination comprising at least one of the foregoing precursors.

16. (Currently amended) The method of ~~claim 1~~claim 15, wherein the precursor is trimethyl aluminum, tetrakis(dimethylamino)hafnium, or a combination comprising at least one of the foregoing precursors.

17. (Currently amended) The method of ~~claim 12~~claim 15, wherein water vapor is used as an oxidant for the precursor in the forming the partial insulating film.

18. (Previously presented) The method of claim 9, wherein the oxidizing gas comprises an oxygen gas, a nitrogen monoxide gas, a nitrous oxide gas, an ozone gas, or a combination comprising at least one of the foregoing gases, or plasma oxygen.

19. (Previously presented) The method claim 9, wherein sequentially repeating a plurality of times comprises sequentially repeating three times.

20. (Previously presented) The method claim 16, wherein sequentially repeating a plurality of times comprises sequentially repeating eight times.

21. (Currently amended) A method of forming an insulating film in a semiconductor device, the method comprising:

sequentially repeating a plurality of times:

forming a partial insulating film by atomic layer deposition employing an Al precursor, an Hf precursor, or a combination comprising at least one of the

foregoing precursors, while employing water vapor gas as oxidant, wherein the partial insulating film has a thickness in the range of 0.3 to 2 nm; and

removing impurities from the partial insulating film, wherein the removing impurities is performed at a temperature greater than 500°C;

wherein the removing impurities comprises:

removing impurities in a first treatment in a reducing gas atmosphere; and

removing impurities in a second treatment in an oxidizing gas atmosphere, and

wherein the removing impurities comprises removing residual carbon.

REMARKS

Claims 1-9 and 13-21 are pending in the present Application.

I. The claim objections.

Applicants respectfully note that the word "comprises" has been added to claim 3, and claims 16 and 17 have been amended to depend from claim 15. Thus, it is respectfully asserted that the claim objections have been overcome.

II. The obviousness rejection of claims 1, 8, and 13-17 based on Paranjpe (US 2003/0003635), as noted on page 2 of the Office Action.

The USPTO respectfully rejects claims 1, 8, and 13-17 under 35 U.S.C. 103(a) as being unpatentable over Paranjpe. Claims 1 is an independent claims.

A. Paranjpe teaches away from removing impurities at a temperature greater than 500°C, and therefore it would not make technical sense to modify the teachings of Paranjpe to remove impurities at greater than 500°C, as claimed in claim 1.

Claim 1 claims in relevant part:

> "removing impurities from the partial insulating film, wherein the removing impurities is **performed at a temperature greater than 500°C**;" **(emphasis added)**

Regarding these limitations, it is respectfully not seen where Paranjpe teaches the claimed method quoted above.

For example, the USPTO respectfully notes on page 3 of the Office Action that Paranjpe does not disclose the specifically claimed range of "greater than 500°C," as claimed in claim 1. The USPTO respectfully attempts to overcome this deficiency in Paranjpe by arguing on page 3 of the Office Action that:

> "Although Paranjpe does not disclose that this temperature is greater than 500°C, it would have been obvious to one having ordinary skill in the art at the time the invention was made to modify the invention of Paranjpe by using a temperature greater than 500°C, since it ahs been held that discovering an optimum value of a result effective variable involves only routine skill in the art."

Applicants are respectfully aware of the USPTO rules regarding optimization of ranges for results effective variables. However, in this particular case, **it is respectfully important to note that Paranjpe specifically states that a wafer is maintained at a "generally low" temperature of 60 and 350°C** (see paragraphs [0009], [0031], and [0051] of Paranjpe, for example). In other words, **Paranjpe "teaches away" from the specifically claimed temperature range of claim 1 of "greater than 500°C"** (see MPEP 2141.02.VI and 2145.X.D).

Thus, because Paranjpe "teaches away" from the specifically claimed temperature range of claim 1 of "greater than 500°C," **it would not make technical sense to modify Paranjpe to use a temperature range of greater than 500°C.** Additionally, even if a new prior art search is performed by the USPTO, it would not make technical sense to modify the primary reference Paranjpe to remove impurities at a temperature greater than 500°C because Paranjpe explicitly teaches away from this limitation of claim 1. Therefore, Paranjpe respectfully does not teach or suggest removing impurities at a temperature greater than 500°C, as claimed in claim 1.

In contrast, present Figure 6 illustrates one possible example of the claimed method quoted above. For example, present Figure 6 shows an impurity removing treatment at step 12. As seen in Figure 6 and explained on page 8, lines 12-15 of the present specification, **the impurity removing treatment is performed at 650°C.** In other words, present Figure 6 illustrates removing impurities at a temperature greater than 500°C, as claimed in claim 1.

The distinction noted above is important and non-trivial because it results in significant advantages over conventional methods. For example, as explained on pages 9-11 of the present specification, the specifically claimed method of claim 1 helps to **better remove impurities while maintaining high reliability of the device.**

Thus, it is respectfully asserted that Paranjpe does not teach or suggest all of the limitations of independent claim 1. Therefore, it is respectfully asserted that independent claim 1 is allowable over Paranjpe.

B. The dependent claims.

As noted above, it is respectfully asserted that independent claim 1 is allowable, therefore, it is further respectfully asserted that dependent claims 8 and 13-17 are also allowable.

III. The obviousness rejections of claims 2-7, 9, and 18-21 based on Paranjpe in view of Colombo (US 2005/0136690), as noted on page 4.

The USPTO respectfully rejects claims 2-7, 9, and 18-21 under 35 U.S.C. 103(a) as being unpatentable over Paranjpe and Colombo.

Applicants respectfully note that independent claims 9 and 21 have been amended to claim "wherein the removing impurities is performed at a temperature greater than 500°C," similar to independent claim 1.

As noted above in Section II, Paranjpe does not teach or suggest removing impurities at a temperature greater than 500°C as claimed in claim 1, and in fact teaches away from using such a temperature range. **Thus, because Paranjpe "teaches away" from temperatures greater than 500°C, Paranjpe cannot be modified by Colombo or any other reference to teach or suggest the specifically claimed limitation of "wherein the removing impurities is performed at a temperature greater than 500°C,"** as claimed in claim 1 (see MPEP 2141.02.VI and 2145.X.D).

Thus, it is respectfully asserted that the cited references, taken either alone or in combination, do not teach or suggest all of the limitations of independent claims 9 and 21.

Additionally, as noted above, it is respectfully asserted that independent claims 1 and 9 are allowable, and therefore it is further respectfully asserted that dependent claims 2-7 and 18-20 are also allowable.

IV. Conclusion.

It is believed that the foregoing amendments and remarks fully comply with the Office Action and that the claims herein should now be allowable. Accordingly, reconsideration and allowance of all of the claims is respectfully requested.

Please contact the undersigned for any reason. Applicants seek to cooperate with the Examiner, including via telephone if convenient for the Examiner.

If there are any additional charges with respect to this Amendment or otherwise, please charge them to Deposit Account No. 06-1130.

Respectfully submitted,

CANTOR COLBURN LLP

By: _/ Daniel P. Lent/____
Daniel P. Lent
Registration No. 44,867

Date: June 21, 2010
CANTOR COLBURN LLP
20 Church Street, 22nd floor
Hartford, CT 06103-3207
Telephone (860) 286-2929
Facsimile (860) 286-0115
Customer No.: 23413